

## LESSON

## 4.5

Name \_\_\_\_\_ Date \_\_\_\_\_

**Study Guide**

For use with pages 193–198

**GOAL****Multiply and divide powers.****EXAMPLE 1****Using the Product of Powers Property**

The sun evaporates  $10^{12}$  tons of water on Earth per day. Find the weight of water evaporated by the sun in  $10^5$  days.

**Solution**

|                                               |   |                                           |   |                |
|-----------------------------------------------|---|-------------------------------------------|---|----------------|
| Tons of water<br>evaporated in<br>$10^5$ days | = | Tons of water<br>evaporated in one<br>day | • | Number of days |
|-----------------------------------------------|---|-------------------------------------------|---|----------------|

$$= 10^{12} \cdot 10^5 \quad \text{Substitute values.}$$

$$= 10^{12 + 5} \quad \text{Product of powers property}$$

$$= 10^{17} \quad \text{Add exponents.}$$

**Answer:** The sun evaporates  $10^{17}$  tons of water in  $10^5$  days.

**Exercises for Example 1**

Find the product. Write your answer using exponents.

1.  $8^3 \cdot 8^{11}$

2.  $7 \cdot 7^6$

3.  $11^{19} \cdot 11^4$

4.  $3^2 \cdot 3^{18} \cdot 3^5$

**EXAMPLE 2****Using the Product of Powers Property**

a.  $x^6 \cdot x^8 = x^{6+8}$  Product of powers property  
 $= x^{14}$  Add exponents.

b.  $13x^7 \cdot 4x^4 = 13 \cdot 4 \cdot x^7 \cdot x^4$  Commutative property of multiplication  
 $= 13 \cdot 4 \cdot x^{7+4}$  Product of powers property  
 $= 13 \cdot 4 \cdot x^{11}$  Add exponents.  
 $= 52x^{11}$  Multiply.

**Exercises for Example 2**

Find the product. Write your answer using exponents.

5.  $x^3 \cdot x^{12}$

6.  $c^9 \cdot c^3$

7.  $4y \cdot 3y^9 \cdot 4y^5$

8.  $5k^3 \cdot 3k^{12} \cdot 4k^8$

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**EXAMPLE 3 Using the Quotient of Powers Property**

- a.  $\frac{9^6}{9^2} = 9^{6-2}$  Quotient of powers property  
 $= 9^4$  Subtract exponents.
- b.  $\frac{17x^{12}}{51x^3} = \frac{17x^{12-3}}{51}$  Quotient of powers property  
 $= \frac{17x^9}{51}$  Subtract exponents.  
 $= \frac{x^9}{3}$  Divide numerator and denominator by 17.

**Exercises for Example 3**

Find the quotient. Write your answer using exponents.

9.  $\frac{7^{18}}{7^5}$       10.  $\frac{15^{21}}{15^{13}}$       11.  $\frac{x^{16}}{x^9}$       12.  $\frac{12k^{10}}{80k^7}$

**EXAMPLE 4 Using Both Properties of Powers**Simplify  $\frac{18n^8 \cdot n^3}{81n^9}$ .

- $\frac{18n^8 \cdot n^3}{81n^9} = \frac{18n^{8+3}}{81n^9}$  Product of powers property  
 $= \frac{18n^{11}}{81n^9}$  Add exponents.  
 $= \frac{18n^{11-9}}{81}$  Quotient of powers property  
 $= \frac{18n^2}{81}$  Subtract exponents.  
 $= \frac{2n^2}{9}$  Divide numerator and denominator by 9.

**Exercises for Example 4**

Simplify.

13.  $\frac{a \cdot a^7}{a^5}$       14.  $\frac{b^7}{b^2 \cdot b^3}$       15.  $\frac{15x^5 \cdot x^8}{90x^{12}}$       16.  $\frac{4z^{13} \cdot 5z^{18}}{25z^5 \cdot z^{12}}$